Revised January 15, 2009

Guidelines for Material Sampling and Testing of Existing Hot Mix Asphalt Pavements and Overlays

INTRODUCTION

The performance and life-span of Hot Mix Asphalt (HMA) pavements and overlays are subject to numerous variables in Illinois. Poor performance of a HMA pavement, or overlay, may result from: a poor design, improper mixture selection, poor construction practices, severe overloads, and inadequate drainage. These may lead to rutting, cracking, and moisture damage of the HMA pavement.

The typical life-span for a first generation HMA overlay in Illinois is between 12 and 15 years. The life-span of each subsequent HMA overlay is typically reduced from the life-span of the previous HMA overlay. The performance of thin lift overlays, or preventative maintenance activities, is highly dependent upon the quality of the underlying materials. Also, pavements with high truck volumes require quality materials in underlying layers.

To select proper designs, guide the mixture selection, and avoid the reuse of damaged materials, an investigation of the existing HMA materials should be performed. Under certain conditions this investigation will include coring the existing pavement followed by laboratory testing for basic volumetric, strength, and durability properties. The cores taken for these investigations should have testing completed as quickly as possible after the coring process in order to preserve the in-situ condition.

Communication between planning personnel, coring personnel, and laboratory personnel is critical for these investigations. The materials testing laboratory should be contacted prior to the coring operation to ensure that the cores will be tested in the appropriate time frame. In addition, once the testing is complete the materials personnel should report the results back to the planning personnel with an explanation of the test results.

The intent of these guidelines is to provide assistance to the district planning and materials sections on the appropriate sampling and testing requirements that should be completed prior to determining a rehabilitation strategy. These guidelines apply for both full-depth HMA pavements and concrete pavements with an HMA overlay. These guidelines should be incorporated into the design of a single-lift, thin, overlay, and may be used to assist in the design of a standard HMA overlay.

Questions and comments concerning this document and the HMA investigation process may be directed to:

HMA Operations Engineer
Bureau of Materials and Physical Research
126 East Ash Street
Springfield, IL 62704
(217) 782 - 7200

PAVEMENT CORING PROCESS

The pavement coring process should involve removal of only those HMA materials that will be necessary for laboratory testing. It is not necessary to core the original concrete of a HMA overlaid pavement. Extreme care to avoid damaging the core should be used during the core extraction process. Screwdrivers, pry bars, and other devices that apply a concentrated force should not be used as they will damage the cores. If a core sample is damaged by the extraction process, a replacement core should be taken.

The attached "Materials Collection Field Report" should be completed for each location cored. Important information included on the report included project information, coring information, and other observations. Once removed, the cores should be cleaned, blotted dry with a cloth rag to remove excess water, and clearly labeled. The cores should be labeled in a manner so that each core can be easily identified. Important information includes location, core number, and lift position. Once labeled, each core should immediately be placed in a water tight, sealed, plastic bag until the time of testing. The process of bagging each core will preserve the in-situ moisture and condition of the core for a short time period. Research has shown that allowing core samples to dry out can lead to erroneous test results.

Once all the core samples have been collected, labeled, and properly bagged they should be taken to the appropriate laboratory for testing. It is advised that the cores be placed in a freezer after being delivered to the testing laboratory. Freezing aids in separating the core lifts from each other and allows the cores to remain nearly unchanged from the insitu condition. Return the cores samples to the bags as soon as possible after separating lifts. The core samples should remain bagged until they are tested. The core samples should be tested as soon as possible after coring in order to acquire the most accurate result for the in-situ condition of the material.

SAMPLING OF MATERIALS FROM 4-LANE FACILITIES

The core sampling of materials from a four lane facility may be performed in both the driving lane and passing lane for both directions of travel depending on the purpose of the investigation. At least one coring location, per direction, should be performed for each existing contract that the proposed contract will affect, regardless of length. If an existing contract is greater than five (5) miles in length, then select one location, per direction, for every five miles of the contract. Please see Figure 1 below.

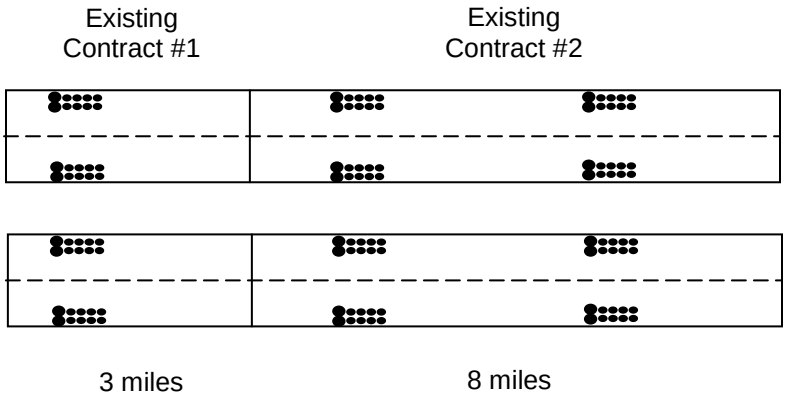


Figure 1
Typical Coring Locations

In addition, if the material sources for an existing contract were changed at some point during construction, then at least one coring location should be selected from each area of various material sources. Finally, if significant changes in the performance of the HMA surface are noted within an existing contract, additional representative cores should be taken from those areas.

At each location to be cored, eight (8) four-inch cores should be taken from either the outside wheel path of the driving lane, the outside wheel path of the passing lane, or both depending on the intent of the coring investigation. Cores may also be taken from between the wheel paths if the comparison with the in the wheel path cores is determined to be necessary. Two (2) 150-mm cores should also be taken from each coring location if Asphalt Pavement Analyzer (APA) rut testing is required. Extreme care should be taken during removal of the cores from the pavement and during transport to the laboratory. The cores should be transported with a flat surface facing down to avoid deformation. Also, avoid leaving the cores in a hot car or truck to avoid degradation. Either of the following two coring patterns located in Figure 2 may be used to remove the cores from the outside wheel path of the roadway.

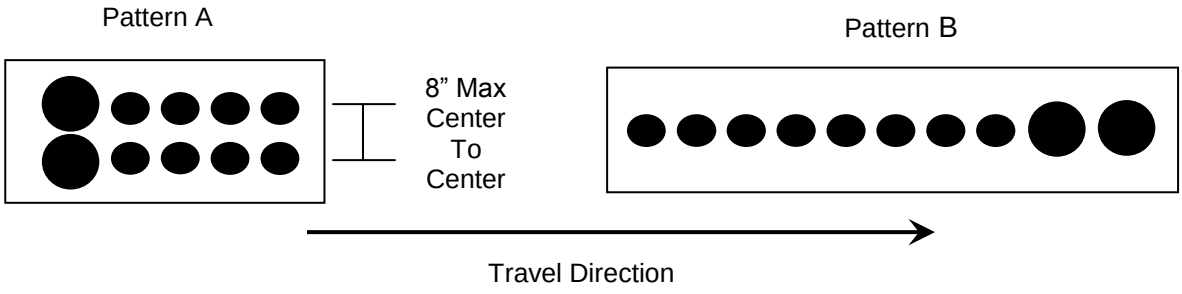


Figure 2
Coring Pattern Options

SAMPLING OF MATERIALS FROM 2-LANE FACILITIES

The core sampling of materials from a two lane facility should be performed in both directions of travel. At least one coring location, per direction, should be performed for each existing contract that the proposed contract will affect, regardless of length. If an existing contract is greater than five (5) miles in length, then select one location, per direction, for every five miles of the contract. Please see Figure 3 below for typical locations.

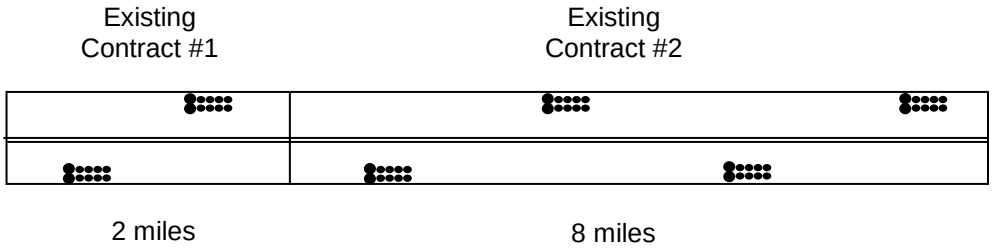


Figure 3
Typical Coring Locations

In addition, if the material sources for an existing contract were changed at some point during construction, then at least one coring location should be selected from each area of various material sources. Finally, if significant changes in the performance of the HMA surface are noted within an existing contract, additional representative cores should be taken from those areas.

Coring locations within 1,000 feet of a rutted or distressed intersection should be avoided as they do not represent the entire existing contract. Due to the difference in loading and distress patterns, coring locations at intersections should only be used to investigate and represent the material in and near the intersection itself.

At each location to be cored, eight (8) four-inch cores should be taken from the outside wheel path of the driving lane. Cores may also be taken from between the wheel paths if the comparison with the in the wheel path cores is determined to be necessary. Two (2) 150-mm cores should also be taken from each coring location if Asphalt Pavement Analyzer (APA) rut testing is required. Extreme care should be taken during removal of the cores from the pavement and during transport to the laboratory. The cores should be transported with a flat surface facing down to avoid deformation. Also, avoid leaving the cores in a hot car or truck to avoid degradation. Either of the two coring patterns located in Figure 2 may be used to remove the cores from the outside wheel path of the roadway.

ADDITIONAL MATERIALS / DATA TO COLLECT

Photographs

A photographic journal of the sample material collection and testing is very important. This information may be used by various individuals throughout the project as a visual identification of the pavement and material condition. Photographs should be taken to document the condition of the pavement in the area of sampling, and the location of the sampling with reference to the lane and wheel path. In addition, a photograph of the coring machine, coring process, and procedure for core extraction may be beneficial when interpreting laboratory results.

Photographs should also be taken of any cores that show significant signs of distress, such as stripping, cracking, or rutting. Once each core has been tested for split tensile strength and strip rated, a photograph should be taken of the split faces with the strip rating reported in the photograph.

Overlay Debonding

All cores that are removed from the pavement should be checked for debonding from the original pavement. There is no test method for this during the coring process. However, it should be noted if the HMA separates from the original pavement during the coring process, or if it must be broken loose during removal. In addition, the interface between the overlay and the original pavement should be checked for mud or other foreign material. It should also be noted if the core debonds at the interface between any lifts or if the core breaks within any lift.

Rutting Measurements

If the pavement is severely rutted in the immediate vicinity of the sampling area, then manual rut depth measurements should be taken and documented for that area. The measurements should be taken with an approved straight edge and rut gauge. These measurements may be used in correlation with the laboratory test results for that coring location.

Pavement Slab Removal

The removal of a pavement slab for investigation is only warranted on projects with moderate to severe rutting throughout the project and 3 or more lifts of HMA. Pavement slab removal is strongly encouraged for severely rutted projects if the surface is under 5 years of age. The resulting slot will allow a measurable determination to be made of each lift's contribution to the overall rut depth. In most cases, a slab removal of one foot wide by six feet long is sufficient in size to perform the investigation. The slab should be taken transversely to traffic flow and from the outside of the lane as shown in Figure 4 below.

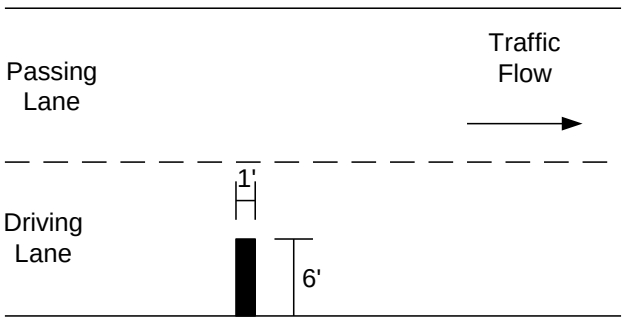


Figure 4
Typical Pavement Slab Removal

Once the slab has been removed, the exposed vertical face of the pavement should be cleaned. A string line should be stretched from end to end of the slab void at the interface of each HMA layer. This string line will indicate which layers are rutting and the severity of the rutting distress. Record the measured results with notes and photographs.

If the slab is needed for further laboratory testing, it should be transported in a manner that will prevent degradation. The slab should not be transported or stored in a hot environment.

Pavement slab removal may or may not be performed at the same time as the coring process. Photographs of the slab removal and the exposed face of the remaining HMA layers, with the string line, should be taken.

CORE SAMPLE TESTING

In the laboratory, the cores should be carefully separated into the appropriate number of lifts and labeled accordingly. The preferred method of separating the individual core lifts is by freezing and splitting them. An alternate method that can be used is by sawing the lifts apart with a concrete saw. This method, however, results in additional cut, uncoated aggregate faces which may cause the gradation to be somewhat finer than what is actually in place.

Special attention should be used to locate any “thin lifts” when separating them from adjacent lifts. A thin lift shall be considered as any lift that is less than three quarters of an inch (3/4”). Thin lifts should be tested for strip rating only.

The materials from all of the following laboratory tests should be saved and bagged in a water-tight, sealed, plastic bag once the testing is complete. If the results of the initial laboratory testing are not conclusive, these materials may be used for additional testing.

Specific Gravity

The bulk specific gravity and maximum specific gravity values are used in the calculation of the percent density of the HMA lifts. The density values provide information on the permeability, compaction, and rutting potential of the pavement.

The bulk specific gravity (G_{mb}) should be determined according to Illinois Modified AASHTO T-166 for each lift (except thin lifts) from six of the cores that are collected. The dry weight for the bulk specific gravity test shall be determined after the split tensile test and strip rating have been performed. **Therefore, extreme caution in handling should be used throughout the testing sequence so as to not lose any pieces of the sample**.

The maximum specific gravity (G_{mm}) for each lift (except thin lifts) should be determined from the material of the remaining two cores. This test should be performed according to Illinois Modified AASHTO T-209. The appropriate lifts of the two cores should be combined to form one sample for testing. If the appropriate amount of material is not acquired from these two lifts, material may be taken from the as-received, unconditioned, split tensile test specimens after all testing is complete.

The percent density should be calculated using the maximum specific gravity and bulk specific gravity values obtained from the core samples. The percent density should also be calculated using the maximum specific gravity values obtained from construction records of the original project (if available) and the bulk specific gravity from the core samples. The difference in these two values gives some indication of the change in density since the project was constructed. Numerical results and a rating for each lift shall be reported as shown in Table 1.

Table 1
Percent Density Ratings

Percent Density	Rating
100 to 98.0	Poor *
97.9 to 96.0	Good
95.9 to 94.0	Excellent
93.9 to 92.0	Good
< 91.9	Poor **

* High potential for severe rutting due to plastic flow.
** High potential for durability and stripping problems.

As-Received Split Tensile Strength

The as-received (unconditioned) split tensile strength value is used as a measure of the strength and condition of the material under current in-situ conditions. This test provides information on the condition of the pavement at the time of the investigation.

Each lift from three out of the six cores tested for bulk specific gravity shall now be placed in a 77 ± 1°F water bath for 2 hours ± 10 minutes and then tested for split tensile strength according to Illinois Modified AASHTO T-283. A strip rating of the broken faces shall be determined on each lift within 10 minutes of the split tensile test. **Care should be taken to not lose any of the lift pieces during the split tensile test**.

The as-received (unconditioned) split tensile strength shall be calculated and reported. A rating for each lift shall also be reported as shown in Table 2.

Table 2
Split Tensile Strength Ratings

Split Tensile Strength (psi)	Rating
> 100	Excellent
80 to 100	Good
50 to 80	Fair
30 to 50	Poor *
< 30	Unstable **

* A material with a split tensile strength rating of "poor" may remain in place on a 2-lane low volume truck route, in the passing lane of a 4-lane facility, and non truck lanes on 6 or more lane facilities. This material should be removed and replaced otherwise.

** An unstable material may be left in place on a low volume, non-truck, route. On all marked routes, this material should be removed and replaced if it will be within 6 inches of the top of the proposed final surface.

Conditioned Split Tensile Strength

The conditioned split tensile strength value is used to simulate the strength and condition of the material under wet, summer conditions. This test provides information on the quality of the pavement under harsh conditions.

Each lift of the remaining three cores tested for bulk specific gravity shall be saturated for 3 minutes under a vacuum of 20 to 25 inches of Mercury. Immediately after saturation, the lifts shall be placed in a 140 ± 1.8°F water bath for 24 ± 1 hours. At the end of the 24 hours, the lifts shall immediately be placed in the 77 ± 1°F water bath for 2 hours ± 10 minutes. Immediately following the 2 hour water bath, the lifts shall be tested for a split tensile strength according to Illinois Modified AASHTO T-283. A strip rating of the broken faces shall be determined on each lift within 10 minutes of the split tensile test. **Care should be taken to not lose any of the lift pieces during the split tensile test.**

The conditioned split tensile strength shall be calculated and reported. A rating for each lift shall also be reported as shown in Table 2.

Visual Strip Rating

The strip rating examination is used to evaluate the moisture damage that is present in the HMA lifts. Stripping of the asphalt cement from the coarse and fine aggregate may lead to raveling, rutting, and isolated shoving of the HMA pavement.

The strip rating examination shall be performed within 10 minutes of the split tensile test. This rating shall be used to determine if there is stripping present on the freshly broken faces of the core, and to visually quantify the amount of stripping that is present for both the coarse and fine aggregate.

The "Stripping of Bituminous Mixtures, Visual Identification and Classification" procedure (attached) should be followed to perform the strip rating examination. Once the strip rating is complete, the lifts should be slowly dried back to a constant mass (dry weight) according to AASHTO T-166 to complete the bulk specific gravity tests. **Care should be taken to not lose any of the lift pieces during the strip rating examination.**

The individual strip rating values for the coarse and fine aggregate shall be reported for each core lift that is tested for split tensile strength. Table 3 describes the numerical strip rating values.

Table 3
Strip Ratings

Strip Rating	Description
1.0 to 1.3	No Stripping to Slight Stripping
>1.3 to 1.7	Slight to Moderate Stripping
>1.7 to 2.3	Moderate Stripping
>2.3 to 2.7	Moderate to Severe Stripping
>2.7 to 3.0	Severe Stripping

OPTIONAL ADDITIONAL TESTING

The following test should only be performed if there is uncertainty with the mixture stability.

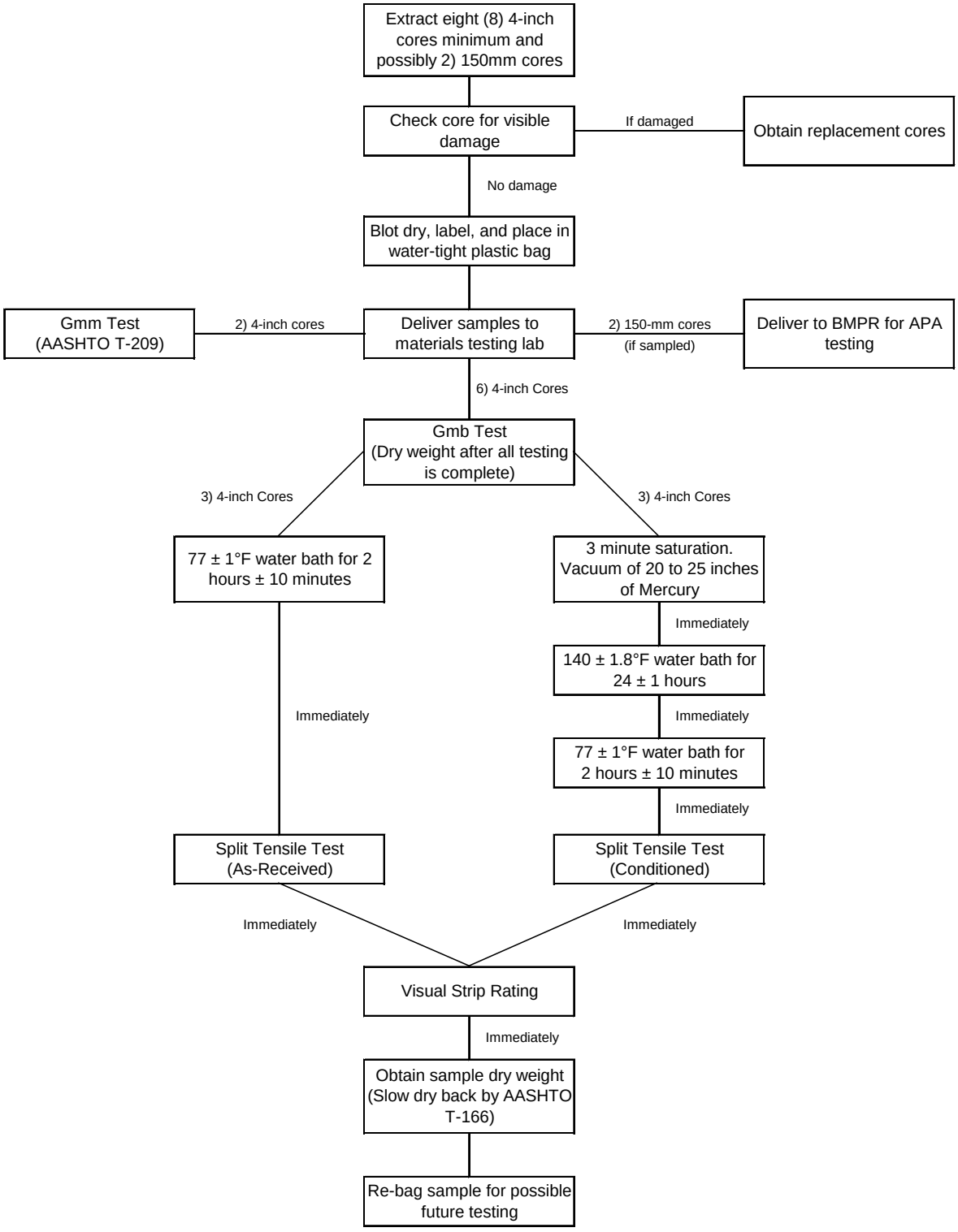
Asphalt Pavement Analyzer (APA)

The APA is used to evaluate the rutting potential that is present in the HMA lifts. The APA uses either a loaded wheel on pressurized hoses that set on top of the HMA sample or a loaded wheel directly on top of the HMA specimen. The loaded wheel directly on the HMA specimen is a harsher test than the loaded wheel with the pressurized hose.

It is important that the core bit used to take the cores is 150mm in diameter and not 6 inches diameter. The larger 6 inch diameter specimens will not fit properly in the APA. The cores should not be allowed to deform in any way during transport and preparation as deformation will also cause the cores to not fit properly in the APA.

Material Testing Flow Chart

(Procedures for cores taken from existing pavements)



Laboratory Testing Summary Report

(Results for cores taken from existing pavements)

Contract #	Route		Coring Station				Lane Cored				Direction Cored	
Test Results for Lift												
Core Label												
Gmm (Laboratory tested)												
Gmm (Construction Record)												
Gmb												
Percent Density (Using Gmm from Construction Records)	Value	Rating	Value	Rating	Value	Rating	Value	Rating	Value	Rating	Value	Rating
Percent Density (Using Gmm from Laboratory Testing)	Value	Rating	Value	Rating	Value	Rating	Value	Rating	Value	Rating	Value	Rating
Conditioned Sample (Y/N)												
Tensile Strength (psi)	Value	Rating	Value	Rating	Value	Rating	Value	Rating	Value	Rating	Value	Rating
Strip Rating (Coarse / Fine)	/		/		/		/		/		/	

Material Collection Field Report

Project Information

Contract #

County

Marked Route

Direction Cored

Lane Cored

Coring Information

Date Cored

Coring Station

Coring Pattern Used

Photographs Taken

Pavement surface at core area	
Coring apparatus	
Core extraction method	
Pavement rut measurements	
Cores prior to testing	
Strip rating faces (as-received)	
Strip rating faces (conditioned)	

Remarks / Observations:

STRIPPING OF HOT MIX ASPHALT MIXTURES -
VISUAL IDENTIFICATION AND CLASSIFICATION

January 1, 2007

The following instructions describe the method to be used for visually identifying and classifying the effect of moisture damage on the adhesion of asphalt binder to the aggregate in Hot Mix Asphalt mixtures. This procedure provides the means to rate this phenomenon in numerical terms. This procedure is applicable to both laboratory compacted specimens and pavement cores[1].

INSTRUCTIONS

1. This procedure should only be applied to freshly split specimen faces, such as those obtained from split tensile testing. The observation of cored, sawed, or chiseled faces should be avoided, as the true condition of the stripping will be obscured.

2. The rating should be completed within ten (10) minutes of splitting for maximum clarity. When the specimens dry out, they may look considerably different. The aggregate surfaces should be examined carefully to determine if the asphalt was stripped from the aggregate as a result of being "washed" by water before the specimen was split or if the asphalt was "ripped apart" near the asphalt/aggregate interface during the split tensile test. Also, aggregate surfaces with small, relatively isolated, globules of asphalt are quite likely not stripped.

3. Special attention should be given to fractured and broken aggregates. Fractured aggregates are those that were cracked during compaction. These fractured aggregates will have a distinct face with a dull or discolored surface. Broken aggregates are those that were broken during the split tensile test. Broken aggregates often occur near the outside surface of the specimen where the compressive forces are greatest. These broken aggregates will also have a distinct broken face, but will have a bright, uncoated surface. The broken aggregates may be a continuation of a crack that was started during compaction. There is no evidence that a broken aggregate was broken entirely under the compressive force of the split tensile test.

4. Coarse aggregate particles shall be defined as those particles retained on the #8 sieve. Fine aggregate particles shall be defined as those particles that will pass through a #8 sieve.

[1] Pavement cores taken from the field should be sealed in plastic bags immediately after coring in order to retain their in-situ moisture. Pavement cores should be split and visually rated as soon as possible after coring to avoid any "healing" of the asphalt to the aggregate surfaces.

5. When examining the split face, use the entire face area of all the fine particles separately from all the coarse particles on the split face to determine the percentage of the total area that is stripped. Do not use the percent of the area of each individual stone that is stripped to collectively determine the percentage of stripped aggregate particles on the entire split face of the specimen. Also, do not estimate the percentage of aggregate particles that are stripped based on the total number of aggregate particles. (i.e., a small stripped aggregate particle does not affect the entire specimen the same as a large stripped aggregate particle.)

PROCEDURE

1. Obtain a freshly split face through the split tensile test.

2. Observe the coarse aggregate of the split face with the naked eye. Pay special attention to the coarse aggregate that is broken or fractured. These particles are not stripped.

3. Assign a strip rating to the coarse aggregate of the split face based on the following descriptions:

   1 - Less than 10% of the entire area of all the coarse aggregate particles is stripped (no stripping to slight stripping).

   2 - Between 10% and 40% of the entire area of all the coarse aggregate particles is stripped (moderate stripping).

   3 - More than 40% of the entire area of all the coarse aggregate particles is stripped (severe stripping).

4. Observe the fine aggregate particles and rate the particles for percent of the area showing moisture damage. A microscope or magnifying glass with a total magnification of 10X should be used to aid in viewing the specimens. Observe the fine aggregate particles and mentally rate the particles present in the field of view. Move the specimen to a new field of view and rate the particles present. Repeat this process once more, ensuring a new field of view is chosen. Average the three (3) observations.

5. Assign a strip rating to the fine aggregate of the split face based on the following descriptions:

   1 - Less than 10% of the entire area of all the fine aggregate particles viewed is stripped (no stripping to slight stripping).

   2 - Between 10% and 25% of the entire area of all the fine aggregate particles viewed is stripped (moderate stripping).

   3 - More than 25% of the entire area of all the fine aggregate particles viewed is stripped (severe stripping).

6. Report the individual strip ratings for both the coarse and fine aggregate on the strip rating form. Include any comments or special notes about the observations from that specimen.